Energy, Mines and Resources Canada | Énergie, Mines et Ressources Canada

**CANMET**

Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

# CRSHEX - A COMPUTER PROGRAM FOR CRUSHING CIRCUIT SIMULATION USER'S GUIDE

M. Bilodeau, D. Laguitton
Mineral Processing Laboratory

October 1988

computers
information systems
crushing
models

**Project:** 30.13.01
Computer Aided Mineral Processing

This document
(CANMET)

16 pp

MINERAL SCIENCES LABORATORIES
DIVISION REPORT MSL 89-30 (TR)

MICROMEDIA

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology
Centre canadien de la technologie des minéraux et de l'énergie

## MICROCOMPUTER SOFTWARE FROM CANMET

CAMP
Computer Aided Mineral Processing
555 Booth Street
Ottawa, Ontario K1A 0G1
Canada

91-00380/

# CRSHEX

## A COMPUTER PROGRAM FOR CRUSHING CIRCUIT SIMULATION

## USER'S GUIDE

M. BILODEAU, E. TER HEIJDEN, D. LAGUITTON

October 1988

CAMP

COMPUTER AIDED MINERAL PROCESSING

CANMET, Energy, Mines and Resources Canada,

552 Booth Street, Ottawa, Ontario, Canada K1A 0G1

TABLE OF CONTENTS


1. INTRODUCTION ..... 1
2. GETTING STARTED ..... 2
2.1 Hardware Requirements ..... 2
2.2 Software Requirements ..... 2
2.2.1 Executable version ..... 2
2.2.1.1 Files on diskettes ..... 2
2.2.2 Source version ..... 3
2.2.2.1 Files on diskettes ..... 3
2.2.3 Operating system ..... 4
2.3 Program Compilation ..... 4
2.4 Program Installation ..... 4
2.4.1 Setting up a subdirectory ..... 4
2.4.2 Storing files in CRSHEX subdirectory ..... 4
2.4.3 Selection of the colours used in CRSHEX ..... 4
2.4.4 Miscellaneous ..... 5
3. PROGRAM STRUCTURE ..... 6
3.1 CRSHEX.EXE ..... 6
3.2 Utility Data Files ..... 7
3.3 Simulator Data File ..... 7
3.4 Executable Procedure and Simulation Modules ..... 7
3.5 Output Files ..... 7
3.6 User Data File ..... 7
3.7 Debugging Files ..... 7
4. PROGRAM OPERATION ..... 8
4.1 Menu Options ..... 8
4.2 Messages ..... 8
4.3 Help ..... 9
4.4 The Flowsheet Creation Options Screen ..... 9
4.5 The Drawing Board ..... 9
4.5.1 The drawing board functions ..... 9
4.5.2 The drawing board access ..... 10
4.5.3 The drawing board help text ..... 10
4.5.4 Flowsheet generation ..... 10
4.5.4.1 Drawing units ..... 12
4.5.4.2 Drawing streams ..... 12
4.5.5 Simulation data entry ..... 13
4.5.5.1 Stream connection matrix ..... 13
4.5.5.2 Circuit feed description and water addition flowrates ..... 13

4.5.5.3 Unit model parameters ..... 15
4.6 Simulation Execution ..... 16
4.7 Simulation Results ..... 16
4.7.1 Results around a specific unit ..... 16
4.7.2 Final results ..... 16
5. PROGRAM CAPABILITIES ..... 20
6. SAMPLE RUN ..... 20
7. MAINTENANCE AND UPDATES ..... 20
8. ACKNOWLEDGEMENTS ..... 20
9. REFERENCES ..... 21

# 1. INTRODUCTION

The simulation of mineral processing circuits, which consists of evaluating liquid and solid distributions on all streams of a flowsheet, is applied to investigate flowsheet modifications, to perform off-line optimization and to design new plants.

The CRSHEX program has been developed at the Canada Centre for Mineral and Energy Technology (CANMET) for the simulation of crushing plants involving Jaw Crushers, Standard and Short Head Cone Crushers, Screens, etc.

In its present version, the CRSHEX program includes the facilities of two other programs (SIMBAL, SPLITX) already available at CANMET. The data editor, inspired by SIMBAL (1, 2, 3), features graphic flowsheet generation and full screen data editing. The material flowrate calculation features the modular approach and convergence acceleration by the Aitkins Delta Squared (ADS) method, developed for SPLITX (4, 5). The unit models, already available in the first version of CRSHEX, feature realistic models based on manufacturer specifications.

A sample run with CRSHEX is performed as follows. The flowsheet is drawn on the screen; the streams are drawn directly and the units are recalled from a list of predefined modules. Once a flowsheet is drawn, the entry of feed data and unit parameters is activated by moving the cursor to the stream or unit and pressing a preprogrammed key. The program then prompts the user with a table in which all the data required can be entered or modified by using full screen editing facilities. After all required data have been entered, the execution of the simulation module can be initiated from the main menu. The results can then be printed for the whole circuit or displayed for a specific unit by moving the cursor to the selected unit and pressing a preprogrammed key.

## 2. GETTING STARTED

### 2.1 Hardware Requirements

- IBM-PC(*), PC XT, PC AT, 386 or compatible
- 640 KB of RAM memory
- 1 Hard disk drive (10 MB or more)
- 1 Soft disk drive (360 KB)
- IBM Colour Graphic Adapter (CGA)
- IBM monochrome composite or RGB colour monitor
- IBM compatible printer like Epson, Panasonic, etc.

The following equipment is optional:

- 1 Math coprocessor 8087
- 1 Epson HI-80 plotter

### 2.2 Software Requirements

Depending on whether the source or executable version is received, the user diskettes contain the following software.

#### 2.2.1 Executable version

The CRSHEX program resides on two 5¼-inch diskettes (non copy protected): diskette 1, EDITOR/DATA FILES; diskette 2, SIMULATOR/INSTALL/SAMPLE RUN.

##### 2.2.1.1 Files on diskettes

| Diskette number | Title | Files |
|---|---|---|
| 1 | EDITOR | CRSHEX.EXE |
| | DATA FILES | CRSHEX.INP |
| | | CRSHEX.RES |
| | | CRSHEX.TXT |
| | | CRSHEX.UNT |
| | | FLOW.STD |
| | | FLO.TXT |
| | | HCRSHEX.BAT |
| | | UNITS.DAT |
| 2 | SIMULATOR | CRSHEX.CRS |
| | INSTALL | INSTALL.DAT |
| | SAMPLE RUN | INSTALL.EXE |
| | | FLOWAN.EXE |
| | | MATFLO.EXE |

(*) IBM is a registered trademark for International Business Machines.

### 2.2.2 Source version

The CRSHEX program resides on four 5¼-inch diskettes (non copy protected): diskette 1, CRSHEX; diskette 2, FLOWAN; diskette 3, MATFLO; diskette 4, SPOC LIBRARY.

#### 2.2.2.1 Files on diskettes

| Diskette number | Title | Files |
|---|---|---|
| 1 | CRSHEX | CRSHEX.CRS |
| | | CRSHEX.FOR |
| | | CRSHEX.INP |
| | | CRSHEX.RES |
| | | CRSHEX.TXT |
| | | CRSHEX.UNT |
| | | CRSHIN.FOR |
| | | FILERS.FOR |
| | | FLO1.FOR |
| | | FLO2.FOR |
| | | FLO.TXT |
| | | FLOW.STD |
| | | HCRSHEX.BAT |
| | | INSTALL.DAT |
| | | INSTALL.FOR |
| | | INTFLO.FOR |
| | | UTIL.FOR |
| | | UNITS.DAT |
| 2 | FLOWAN | FLOWAN.FOR |
| | | FLSUB1.FOR |
| | | FLSUB2.FOR |
| | | FLSUB3.FOR |
| | | FLSUB4.FOR |
| | | FLSUB5.FOR |
| 3 | MATFLO | COMPLEX.FOR |
| | | CR1.FOR |
| | | CR2.FOR |
| | | CR3.FOR |
| | | FLOCAL.FOR |
| | | MATFLO.FOR |
| | | MATINP.FOR |
| | | MATOUT.FOR |
| | | MATUNIT.FOR |
| | | MSUB.FOR |
| | | RDSTRM.FOR |
| 4 | SPOC LIBRARY | SPOC2.LIB |

### 2.2.3 Operating system

MS-DOS Version 3.00 or higher. The ANSI driver system must be installed; see your DOS operating system for more information (6).

## 2.3 Program Compilation

If the source version is used, all the files must be compiled using the Microsoft Fortran Compiler, Version 4.01 (7). Refer to the user's guide to install the compiler.

All files with extension "FOR" must be compiled using the following command:

```
FL /FPi /c /Od /W0 *.FOR
```

They are then linked in the following way:

```
LINK INSTALL,,,LLIBFORE+LCLIB1+SPOC2;

LINK CRSHEX+FLO1+FLO2+INTFLO+UTIL+FILERS+CRSHIN+
        ,,,LLIBFORE+LCLIB1+SPOC2;

LINK FLOWAN+FLSUB1+FLSUB2+FLSUB3+FLSUB4+FLSUB5+RDSTRM
        ,,,LLIBFORE+LCLIB1;

LINK MATFLO+COMPLEX+MATINP+FLOCAL+MATOUT+RDSTRM+MATUNIT+
        MSUB+CR1+CR2+CR3,,,LLIBFORE+LCLIB1;
```

## 2.4 Program Installation

The following instructions assume that the user has received the executable version. If the source version is used, it is necessary to create a set of executable disks, as presented in section 2.2.1 (Executable version), before using these instructions.

### 2.4.1 Setting up a subdirectory

Return system to root directory (C> or D>), type MD\CRSHEX and press <RETURN>. A subdirectory called CRSHEX will be created. Any name, other than CRSHEX, can be used.

### 2.4.2 Storing files in CRSHEX subdirectory

1. To access the subdirectory CRSHEX, type CD\CRSHEX at the DOS prompt.
2. Insert the two diskettes sequentially in drive A and type COPY A:*.* at each DOS prompt. All the files on the two diskettes are then copied to the subdirectory CRSHEX.

### 2.4.3 Selection of the colours used in CRSHEX

All the colour codes used in CRSHEX can be changed with the program INSTALL.EXE. A help text showing all the possible colours with their numeric codes is supplied with the

INSTALL program. The user will notice that a different method must be used to enter the colour used by DOS. The background and foreground colour codes must be specified because the colour is fixed using the ANSI driver technique instead of the ROM BIOS technique. Further information on this subject may be found in the literature (8, 9, 10, 11).

### 2.4.4 Miscellaneous

1. Since CRSHEX requires about 440 KB of core, the user must ensure, before running CRSHEX, that no large programs such as SideKick (12) are resident in memory.

2. To print the flowsheet on the printer by using the combination of keys Shift and PrtSc, the user must include the statement GRAPHICS in the AUTOEXEC.BAT file. Check the disk operating system manual (6) for more information about the GRAPHICS command and the AUTOEXEC.BAT file.

## 3. PROGRAM STRUCTURE

The CRSHEX program consists of one main driver (CRSHEX), which supervises the execution of the program, one batch file (HCRSHEX.BAT), which controls the execution of the simulation modules, and the simulation modules themselves (FLOWAN.EXE, MATFLO.EXE). The link between all these programs is made by data files. Figure 1 shows a general overview of the complete program.

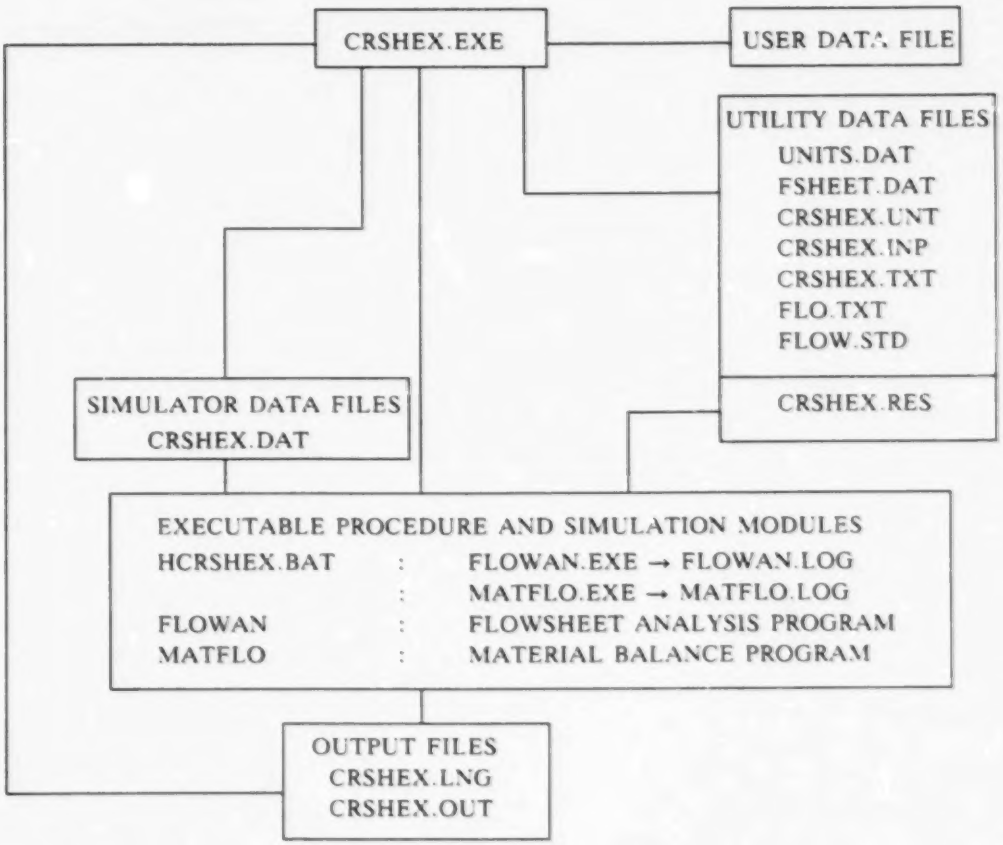


Figure 1: Structure of CRSHEX program

### 3.1 CRSHEX.EXE

CRSHEX contains two main modules: the main menu from which the complete operation of the program is controlled and the editor used to draw the flowsheet and to enter all data needed for the simulation.

### 3.2 Utility Data Files

These files contain operating data for CRSHEX. They must not be modified by the user.

| | | |
|---|---|---|
| CRSHEX.INP | : | Data required to display the screen used for unit parameters and feed data entry. |
| CRSHEX.RES | : | Data required to build result tables (called subroutine FINPRT in MATFLO.EXE). |
| CRSHEX.UNT | : | Data required to display the main menu screen. |
| UNITS.DAT | : | Contains predefined unit diagrams. This file is created by a separate program called DRAW, which allows the user to create his/her own unit diagrams. DRAW is not included with CRSHEX but is available separately. |
| FSHEET.DAT | : | Temporary file used to keep a record of the flowsheet. |
| CRSHEX.TXT | : | CRSHEX help text. |
| FLO.TXT | : | Drawing board help text. |
| FLOW.STD | : | Typical size distribution after blasting. The user may select any of them or enter his/her own. |

### 3.3 Simulator Data File

This file (CRSHEX.DAT) is created by the main driver (CRSHEX) and used by the simulation programs (FLOWAN.EXE AND MATFLO.EXE). It contains all the data required to perform a simulation.

### 3.4 Executable Procedure and Simulation Modules

These programs analyze the flowsheet and execute the simulation by using the appropriate unit models. The simulation results are temporarily written to the two output files CRSHEX.LNG and CRSHEX.OUT. Further information about the flowrate calculation technique and unit simulation models may be found in the SPOC manual, Chapter 6, SPLITX and CRSHEX (5).

### 3.5 Output Files

The two output files present the results in two different forms.

CRSHEX.OUT: The results are displayed for each unit. This file is used to scan the results around a specific unit.

CRSHEX.LNG: The results are presented stream by stream. This file is used to print the complete distribution of material on all streams.

### 3.6 User Data File

This file contains all data entered by the user, i.e., flowsheet, feed description and unit parameters. The file name is selected by the user. One user data file (CRSHEX.CRS) is supplied with the program as an example. It contains the sample run presented in the SPOC manual, Chapter 6, pp 72–92 (5).

### 3.7 Debugging Files

The two files (FLOWAN.LOG and MATFLO.LOG) contain supplemental results about flowsheet analysis and flowrate convergence calculations.

## 4. PROGRAM OPERATION

To start the program, the user must access the CRSHEX subdirectory (CD\CRSHEX) and then load the program in memory by typing CRSHEX on the keyboard. The main menu of the program is then displayed on the screen as shown in Figure 2.

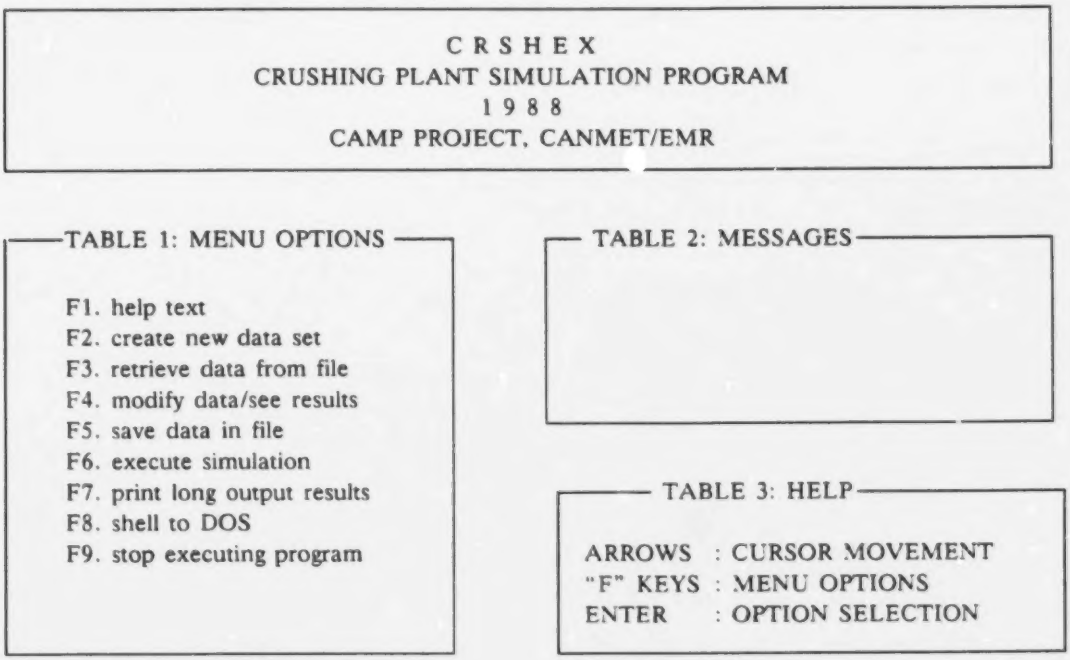
C R S H E X
CRUSHING PLANT SIMULATION PROGRAM
1 9 8 8
CAMP PROJECT, CANMET/EMR
TABLE 1: MENU OPTIONS
F1. help text
F2. create new data set
F3. retrieve data from file
F4. modify data/see results
F5. save data in file
F6. execute simulation
F7. print long output results
F8. shell to DOS
F9. stop executing program
TABLE 2: MESSAGES
TABLE 3: HELP
ARROWS : CURSOR MOVEMENT
"F" KEYS : MENU OPTIONS
ENTER : OPTION SELECTION

Figure 2: CRSHEX main menu

### 4.1 Menu Options

In this menu, the available options are initiated by either pressing the corresponding <F> key or moving the highlighted bar to the chosen option and pressing the <RETURN> key.

Select:

F1: to visualize the help text associated with the CRSHEX simulator.

F2: to delete present data and create a new data set.

F3: to delete present data and load a new data set from disk file.

F4: to modify a set of data already loaded in memory or to display the results around a unit.

F5: to save the current data set in a disk file.

F6: to run the simulation.

F7: to print the simulation results and all input data.

F8: to shell to DOS.

F9: to stop program.

### 4.2 Messages

Table 2 on the main menu (Figure 2) is used by the program to communicate with the user.

## 4.3 Help

The help text in Table 3 on the main menu (Figure 2) indicates how an option is selected on the main menu.

1. Arrows: cursor movement

   - arrow keys located on the keypad control movement of the highlighted bar.

2. <Enter>: option selection

   - <RETURN> key can be used to select the option highlighted by a bar.

3. <F> keys: menu options

   - <F> keys can be used to select an option.

## 4.4 The Flowsheet Creation Options Screen

When option <F2> (create new set of data) is selected from the option menu, the flowsheet creation options, as shown in Figure 3, are displayed.

```
FLOWSHEET CREATION OPTIONS
==========================

UNIT SCALE (1:5x8 mm, 10:50x80 mm)              :    3
STREAM/UNIT NUMBERING (0:MANUAL / 1:AUTO)       :    1

F9: Keyboard Help        F10: Save and Exit        Esc: Exit without saving
```

Figure 3: Flowsheet creation options

1. Unit Scale (1-10):

   This factor is used to size unit diagrams with an absolute value. A value of 2, for example, produces unit diagrams twice as big as a value of 1, which exhibits unit diagrams about 5 mm high by 8 mm wide. A value of 3 is recommended.

2. Stream/Unit Numbering:

   Select 0 if stream and unit numbers must be entered manually. Select 1 if stream and unit numbers must be generated automatically by the program.

## 4.5 The Drawing Board

### 4.5.1 The drawing board functions

The drawing board in CRSHEX has three different functions:

1. to draw the flowsheet;
2. to enter feed description and unit model parameters;
3. to display simulation results around a specific unit.

### 4.5.2 The drawing board access

To access the drawing board, select one of the following options from the main menu:

F2. create new set of data;
F3. retrieve data from file;
F4. modify data/see results.

### 4.5.3 The drawing board help text

The help text contains a definition of all the preprogrammed keys used on the drawing board. It is displayed (Figure 4) before accessing the drawing board and can also be consulted later from the drawing board by pressing the <?> key. From the help text, the user can return to the main menu by pressing <Q> or <Esc> or go to the drawing board by pressing <F10>.

### 4.5.4 Flowsheet generation

Figure 5 shows the screen image of a flowsheet. Streams are drawn directly on the screen and units are recalled from a list of predefined modules contained in the data file UNITS.DAT. A list of available units is presented in Figure 6.

DRAWING BOARD HELP TEXT

The drawing board is used to:
1. Draw the flowsheet;
2. Enter feed data and unit parameters;
3. Visualize results around units.

NOTE: 1. It is strongly recommended that units be drawn before streams.
2. Print this help text (Shift–PScrn) for later consultation.

PROGRAMMED KEYS:

| | |
|---|---|
| (S) START STREAM (ANY KEY FOR CORNER) | (H) HARD COPY ON EPSON HI-80 |
| (T) TERMINATE STREAM | (M) SEE STREAM CONNECTION MATRIX |
| (U) PLACE UNIT | (R) RESOLUTION HIGH/MEDIUM |
| (C) COLOUR ALL UNITS | (G) DISPLAY GRID |
| (D) DELETE UNIT/STREAM | (N) REDRAW THE SCREEN |

(I) INPUT FEED DATA OR UNIT PARAMETERS
(W) INPUT OF WEIGHTING FACTOR (SPLITX)
(O) RESULTS AROUND A UNIT AT CURSOR POSITION

(?) ACCESS THE PRESENT MENU AT ANY TIME FROM THE DRAWING BOARD
(Esc/Q) EXIT THE DRAWING BOARD AND RETURN TO MAIN MENU

Esc/Q: Go to main menu F10: Continue

Figure 4: The drawing board help text

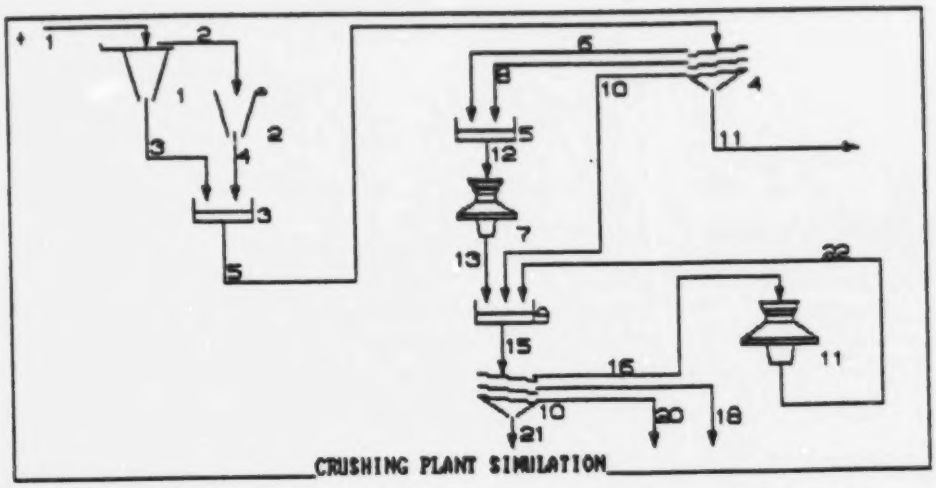


Figure 5: Flowsheet generated by CRSHEX

*** UNIT CODE LIST ***

NOTE: USE CAPITAL LETTERS TO ENTER UNIT CODES

| UNIT CODE | UNIT DESCRIPTION |
|---|---|
| MIX | MIXER |
| SEP | SEPARATOR |
| FEG | FEEDER WITH GRIZZLY |
| FED | FEEDER WITHOUT GRIZZLY |
| SH4 | SCREEN HORIZONTAL 4 DECKS |
| SH3 | SCREEN HORIZONTAL 3 DECKS |
| SH2 | SCREEN HORIZONTAL 2 DECKS |
| SH1 | SCREEN HORIZONTAL 1 DECK |
| SI4 | SCREEN INCLINED 4 DECKS |
| SI3 | SCREEN INCLINED 3 DECKS |
| SI2 | SCREEN INCLINED 2 DECKS |
| SI1 | SCREEN INCLINED 1 DECK |
| JAW | JAW CRUSHER |
| GIR | GIRATORY CRUSHER |
| CST | STANDARD CONE CRUSHER |
| CSH | SHORT HEAD CONE CRUSHER |
| IMP | IMPACT CRUSHER |
| HAM | HAMMER CRUSHER |
| CTH | OTHER CRUSHER |
| PIL | STOCK PILE |
| SIL | SILO |

PgUp/PgDn Home/End Esc: Exit

Figure 6: List of available units

#### 4.5.4.1 Drawing units

To draw a unit on the screen the following steps must first be taken:

1. Move the cursor to the desired location. Three different combinations of keys can be used to move the cursor:

   a. Arrow keys alone : the cursor is moved 8 pixels at a time.
   b. <Shift> + arrow keys : the cursor is moved 1 pixel at a time.
   c. <Ctrl> + arrow keys : the cursor is moved 16 pixels at a time; available only for left–right motion.

   Note: Depending on the state of the <NumLock> key, option 1 and 2 may be inverted.

2. Press <U> (for unit) on the keyboard.

   The following questions are then displayed at the top of the screen:

   a. Unit code, ? for list, X to exit ?

      You may enter:

      (1) unit code as shown in Figure 6 for the desired unit;
      (2) unit code plus <*>, e.g., BML*, to draw the unit with a rotation of 180 degrees around vertical axis in screen plane;
      (3) <?> to visualize the available unit list presented in Figure 6;
      (4) <X> to exit unit drawing option.

   b. Unit number ?

      This question is displayed when manual numbering has been selected from the flowsheet generation options screen. Enter any number from 1 to 99 not already used.

   c. Number location: use cursor, hit <space>

      The user may accept the default position and press the space bar, or move the cursor to the desired location and press the space bar. The unit number is drawn next to the cursor (the reference point is the lower left corner of the number).

#### 4.5.4.2 Drawing streams

To draw a stream on the flowsheet, the user must:

1. Move the cursor to the stream starting point and press <S> to activate stream drawing option.
2. If elbows or corners are required, move the cursor to the desired location and press any key (except <T>).
3. Press <T> to terminate stream drawing option. An arrow is automatically displayed.

Note: It is advisable to draw the units first since it is much easier to connect them neatly with streams after.

At this stage the program displays questions related to stream numbering similar to the questions presented in section 4.5.4.1.

### 4.5.5 Simulation data entry

The data required to perform a simulation consist of:

1. stream connection matrix (see section 4.5.5.1);
2. description of the feed to the plant and all the water addition flowrates;
3. unit model parameters.

#### 4.5.5.1 Stream connection matrix

The stream connection matrix is generated automatically (3) from the flowsheet on the drawing board. It can always be viewed by pressing the <M> key. The representation of the stream connection matrix associated with the flowsheet in Figure 5 is shown in Table 1.

In this table, the rows represent the streams: column 1 is the stream index; column 2 is the stream number; column 3 is the number of the originating unit; and column 4 is the destination unit number. Zero entries represent origins and destinations outside the flowsheet and are used to represent feed and output streams, respectively.

Table 1: Stream connection matrix of flowsheet in Figure 5

| STREAM-INDEX | STREAM-NUMBER | ORG. UNIT | DEST. UNIT |
|---|---|---|---|
| 1 | 1 | 0 | 1 |
| 2 | 2 | 1 | 2 |
| 3 | 4 | 2 | 3 |
| 4 | 3 | 1 | 3 |
| 5 | 5 | 3 | 4 |
| 6 | 8 | 4 | 5 |
| 7 | 6 | 4 | 5 |
| 8 | 12 | 5 | 7 |
| 9 | 13 | 7 | 9 |
| 10 | 10 | 4 | 9 |
| 11 | 16 | 10 | 11 |
| 12 | 22 | 11 | 9 |
| 13 | 15 | 9 | 10 |
| 14 | 18 | 10 | 0 |
| 15 | 20 | 10 | 0 |
| 16 | 21 | 10 | 0 |
| 17 | 11 | 4 | 0 |
| PgUp/PgDn | Home/End | Esc: Exit | |

#### 4.5.5.2 Circuit feed description and water addition flowrates

To enter the feed description or water addition flowrates, the user must move the cursor to the corresponding stream on the flowsheet and press <I>. The program then displays three

tables (Tables 2, 3 and 4) into which may be entered all the information required to describe the feed to the plant.

As shown in Tables 2, 3 and 4, the material constituting the feed and all other streams is defined by its solid and water flowrates and by its size distribution. Other physical properties, such as the Bond Work index and density, are also used as model parameters.

Table 2: Table used to enter feed data and water addition flowrates

FEED DATA

| | | |
|---|---|---|
| 1. | TYPE OF MATERIAL (Enter the number) | : |
| | 1) Limestone, 2) Granite, 3) Trap Rock | LIMESTONE |
| | 4) Ore, 5) Others | |
| | ENTER CHOICE NUMBER | : 1 |
| | ENTER TYPE IF OPTION #5 IS SELECTED | : LIMESTONE |
| 2. | CONDITION OF MATERIAL (ANY COMMENT) | : NORMAL |
| 3. | DENSITY OF MATERIAL (1-10 TONNES/CUBIC METRE) | : 1.6000 |
| 4. | BOND INDEX (WI) (1-30 KWH/TONNE) | : 10.0000 |
| 5. | WATER FLOWRATE (1-20000 TONNES/HOUR) | : .0000 |
| 6. | SOLID FLOWRATE (1-20000 TONNES/HOUR) | : 400.0000 |

F9: Keyboard Help F10: Save and Exit Esc: Exit without saving

Table 3: Table used to select feed size distribution

FEED SIZE DISTRIBUTION

THE FOLLOWING TYPICAL SIZE DISTRIBUTIONS AFTER BLASTING CAN BE SELECTED FROM A FILE OR YOU CAN ENTER YOUR OWN BY SELECTING OPTION "15".

| | | | | | |
|---|---|---|---|---|---|
| 1. | GRANITE | 0-36 IN | 9. | TRAP ROCK | 0-36 IN |
| 2. | GRANITE | 0-24 IN | 10. | TRAP ROCK | 0-24 IN |
| 3. | GRANITE | 0-20 IN | 11. | TRAP ROCK | 0-20 IN |
| 4. | GRANITE | 0-18 IN | 12. | TRAP ROCK | 0-18 IN |
| 5. | LIMESTONE | 0-36 IN | 13. | GRAVEL | 0-12 IN |
| 6. | LIMESTONE | 0-24 IN | 14. | GRAVEL | 0-8 IN |
| 7. | LIMESTONE | 0-20 IN | | | |
| 8. | LIMESTONE | 0-18 IN | 15. | OTHER | |

ENTER YOUR CHOICE: 6

F9: Keyboard Help F10: Save and Exit Esc: Exit without saving

Table 4: Table used to enter feed size distribution

SIZE DISTRIBUTION (% CUMULATIVE PASSING)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1219.2 | mm | : | 100.0000 | 25 | mm | : | 8.0000 |
| 610 | mm | : | 100.0000 | 19 | mm | : | 5.0000 |
| 305 | mm | : | 74.0000 | 12.7 | mm | : | 3.0000 |
| 203 | mm | : | 56.0000 | 9.5 | mm | : | 1.5000 |
| 152 | mm | : | 46.0000 | 4 | mesh | : | .5000 |
| 102 | mm | : | 34.0000 | 8 | mesh | : | .2000 |
| 89 | mm | : | 31.0000 | 16 | mesh | : | .0000 |
| 76 | mm | : | 28.0000 | 30 | mesh | : | .0000 |
| 63 | mm | : | 23.0000 | 50 | mesh | : | .0000 |
| 51 | mm | : | 18.0000 | 200 | mesh | : | .0000 |
| 38 | mm | : | 13.0000 | | | | |

MAXIMUM BLOCK SIZE (inches): 24.0000

PgUp/PgDn F9: Keyboard Help F10: Continue Esc: Exit

By convention, the solid flowrate defining a water addition stream will be given a value of 0 because there are no solids in such a stream.

4.5.5.3 Unit model parameters

The parameters defining unit models can also be entered by moving the cursor to the unit and pressing <I>. Depending on the unit code (JAW, SI3, CST, CSH, MIX, SEP, etc.) the program prompts the user with the appropriate table. A representation of such a table is given in Table 5 for a jaw crusher unit.

For separator unit, a convention is that the split factor is the fraction of the feed material that passes to the higher output stream on the screen. If the separator has three output streams, the second split factor applies to the second highest stream.

Table 5: Table used to enter jaw crusher parameters

JAW CRUSHER

| | | |
|---|---|---|
| 1. Model | : | J-3048 |
| 2. Capacity (1-7500 tph) | : | 311.0000 |
| 3. Maximum opening (1-1500 mm) | : | 762.0000 |
| 4. Setting (3-410 mm) | : | 152.0000 |

F9: Keyboard Help F10: Save and Exit Esc: Exit without saving

For an explanation of the unit models as well as a description of their capabilities and limitations, the user is referred to SPOC manual, Chapter 6 (5).

## 4.6 Simulation Execution

To execute the simulation, the user must first leave the drawing board and return to the main menu. This is done by pressing the <Q> or <Esc> keys. From the main menu, the option F6 (Execute simulation) must then be selected.

## 4.7 Simulation Results

After the simulation module has been executed, the user is returned to the main menu from which the results may be visualized in two different forms: final results or results around a specific unit.

### 4.7.1 Results around a specific unit

To examine material flowrates for a specific unit, return to the flowsheet (option F4 from the main menu) and move the cursor to the desired unit and press <O>. Table 6 (a, b, c, d) gives an example of the results for a JAW crusher.

### 4.7.2 Final results

A hard copy of the final results can be obtained by choosing option F7 (Print final results) from the main menu. This provides a listing of all data entered, the results around all units and a complete distribution of material in all the streams. Table 7 gives the complete distribution of material for the first two streams of the flowsheet presented in Figure 5.

Table 6 (a): Results around a JAW crusher

| JAW CRUSHER | | |
|---|---|---|
| 1. Model | : | J-3048 |
| 2. Capacity (tph) | : | 311.0000 |
| 3. Maximum opening (mm) | : | 609.6000 |
| 4. Setting (mm) | : | 152.0000 |
| EFFICIENCY (%) | : | 85.2000 |
| R/REDUCTION | : | 4.0655 |
| ENERGY CONSUMPTION (KWH) | : | 39.6959 |
| PgUp/PgDn Home/End | | Esc: Exit |

Table 6 (b): Results around a JAW crusher

MACROSCOPIC DATA

| | | STR#2 | STR#4 |
|---|---|---|---|
| SOLID FLOWRATE (tph) | : | 265.0 | 265.0 |
| WATER FLOWRATE (tph) | : | .0 | .0 |
| MAX. BLOCK SIZE (mm) | : | 609.6 | 253.0 |
| PgUp/PgDn | Home/End | | Esc: Exit |

Table 6 (c): Results around a JAW crusher

SIZE DISTRIBUTION (% RETAINED)

| SIZE | | | | STR#2 | STR#4 |
|---|---|---|---|---|---|
| 1219 | – 610 | mm | | .0 | .0 |
| 610 | – 305 | mm | | 39.2 | .0 |
| 305 | – 203 | mm | | 27.2 | 3.2 |
| 203 | – 152 | mm | | 15.1 | 11.4 |
| 152 | – 102 | mm | | 15.1 | 23.6 |
| 102 | – 89 | mm | | 1.7 | 6.6 |
| 89 | – 76 | mm | | .8 | 6.9 |
| 76 | – 63 | mm | | .6 | 6.8 |
| 63 | – 51 | mm | | .2 | 6.8 |
| 51 | – 38 | mm | | .0 | 6.9 |
| 38 | – 25 | mm | | .1 | 6.8 |
| 25 | – 19 | mm | | .0 | 3.4 |
| 19 | – 12.7 | mm | | .0 | 5.4 |
| 12.7 | – 9.5 | mm | | .0 | 2.7 |
| 9.5 | – 4.8 | mm | | .0 | 3.6 |
| 4 | – 8 | mesh | | .0 | 2.3 |
| 8 | – 16 | mesh | | .0 | 1.6 |
| 16 | – 30 | mesh | | .0 | 1.3 |
| 30 | – 50 | mesh | | .0 | .7 |
| 50 | – 200 | mesh | | .0 | .0 |
| (–200) | | mesh | | .0 | .0 |
| PgUp/PgDn | | | Home/End | | Esc: Exit |

Table 6 (d): Results around a JAW crusher

SIZE DISTRIBUTION (% CUMULATIVE PASSING)

| SIZE | | | | STR#2 | STR#4 |
|---|---|---|---|---|---|
| 1219 | – | 610 | mm | 100.0 | 100.0 |
| 610 | – | 305 | mm | 60.8 | 100.0 |
| 305 | – | 203 | mm | 33.6 | 96.8 |
| 203 | – | 152 | mm | 18.5 | 85.4 |
| 152 | – | 102 | mm | 3.4 | 61.8 |
| 102 | – | 89 | mm | 1.7 | 55.2 |
| 89 | – | 76 | mm | .9 | 48.3 |
| 76 | – | 63 | mm | .3 | 41.5 |
| 63 | – | 51 | mm | .1 | 34.7 |
| 51 | – | 38 | mm | .1 | 27.8 |
| 38 | – | 25 | mm | .0 | 21.0 |
| 25 | – | 19 | mm | .0 | 17.6 |
| 19 | – | 12.7 | mm | .0 | 12.2 |
| 12.7 | – | 9.5 | mm | .0 | 9.5 |
| 9.5 | – | 4.8 | mm | .0 | 5.9 |
| 4 | – | 8 | mesh | .0 | 3.6 |
| 8 | – | 16 | mesh | .0 | 2.0 |
| 16 | – | 30 | mesh | .0 | .7 |
| 30 | – | 50 | mesh | .0 | .0 |
| 50 | – | 200 | mesh | .0 | .0 |
| (–200) | | | mesh | .0 | .0 |

PgUp/PgDn Home/End Esc: Exit

Table 7: Complete distribution of material

CRUSHING CIRCUIT SIMULATION RESULTS

| STREAM NUMBER | SOLID FLOWRATE (TPH) | WATER FLOWRATE (TPH) | MAXIMUM BLOCK (MM) | SIZE | MATERIAL RETAINED (%) | MATERIAL CUM. PAS. (%) |
|---|---|---|---|---|---|---|
| 1 | 400.0 | .0 | 609.6 | 1219 – 610 mm | .0 | 100.0 |
| | | | | 610 – 305 mm | 26.0 | 74.0 |
| | | | | 305 – 203 mm | 18.0 | 56.0 |
| | | | | 203 – 152 mm | 10.0 | 46.0 |
| | | | | 152 – 102 mm | 12.0 | 34.0 |
| | | | | 102 – 89 mm | 3.0 | 31.0 |
| | | | | 89 – 76 mm | 3.0 | 28.0 |
| | | | | 76 – 63 mm | 5.0 | 23.0 |
| | | | | 63 – 51 mm | 5.0 | 18.0 |
| | | | | 51 – 38 mm | 5.0 | 13.0 |
| | | | | 38 – 25 mm | 5.0 | 8.0 |
| | | | | 25 – 19 mm | 3.0 | 5.0 |
| | | | | 19 – 12.7 mm | 2.0 | 3.0 |
| | | | | 12.7 – 9.5 mm | 1.5 | 1.5 |
| | | | | 9.5 – 4.8 mm | 1.0 | .5 |
| | | | | 4 – 8 mesh | .3 | .2 |
| | | | | 8 – 16 mesh | .2 | .0 |
| | | | | 16 – 30 mesh | .0 | .0 |
| | | | | 30 – 50 mesh | .0 | .0 |
| | | | | 50 – 200 mesh | .0 | .0 |
| | | | | (–200) mesh | .0 | .0 |
| 2 | 265.0 | .0 | 609.6 | 1219 – 610 mm | .0 | 100.0 |
| | | | | 610 – 305 mm | 39.2 | 60.8 |
| | | | | 305 – 203 mm | 27.2 | 33.6 |
| | | | | 203 – 152 mm | 15.1 | 18.5 |
| | | | | 152 – 102 mm | 15.1 | 3.4 |
| | | | | 102 – 89 mm | 1.7 | 1.7 |
| | | | | 89 – 76 mm | .8 | .9 |
| | | | | 76 – 63 mm | .6 | .3 |
| | | | | 63 – 51 mm | .2 | .1 |
| | | | | 51 – 38 mm | .0 | .1 |
| | | | | 38 – 25 mm | .1 | .0 |
| | | | | 25 – 19 mm | .0 | .0 |
| | | | | 19 – 12.7 mm | .0 | .0 |
| | | | | 12.7 – 9.5 mm | .0 | .0 |
| | | | | 9.5 – 4.8 mm | .0 | .0 |
| | | | | 4 – 8 mesh | .0 | .0 |
| | | | | 8 – 16 mesh | .0 | .0 |
| | | | | 16 – 30 mesh | .0 | .0 |
| | | | | 30 – 50 mesh | .0 | .0 |
| | | | | 50 – 200 mesh | .0 | .0 |
| | | | | (–200) mesh | .0 | .0 |

## 5. PROGRAM CAPABILITIES

The limitations in CRSHEX are as follows:

| | | |
|---|---|---|
| Number of units | : | 25 |
| Number of streams | : | 80 |
| Number of feed streams | : | 10 |
| Number of size intervals | : | 20 |
| Number of specific gravity | : | 1 |
| Number of characteristics | : | 1 |

## 6. SAMPLE RUN

Diskette 2 (SIMULATOR/INSTALL/SAMPLE RUN) contains a sample run called CRSHEX.CRS. To run it, the user should choose option F3 (Retrieve data from file) from the main menu. For further information, the user is referred to SPOC manual, Chapter 6 (5).

## 7. MAINTENANCE AND UPDATES

CANMET does not provide any formal maintenance of the programs but would appreciate receiving comments on modifications that could substantially improve the overall performance of the program.

## 8. ACKNOWLEDGEMENTS

The authors gratefully acknowledge J. Leung, R. Pilgrim and D. Cimon for reviewing the manuscript.

## 9. REFERENCES


1. D. Laguitton and M. Bilodeau, *Computer Aided Mineral Processing: Simulation and Expert Systems*, Proceedings of the Copper 1987 Conference, Vol. 2, Vina del Mar, Chile, November 1987.

2. M. Bilodeau and D. Laguitton, *SIMBAL, A Computer Program for Mineral Processing Circuit Simulation, User's Guide*, CANMET, Energy, Mines and Resources Canada, 1988.

3. R.P. King, *MODSIM – A modular method for the design, balancing and simulation of ore dressing plant flowsheets*, Report No. 69, Department of Metallurgy, University of Witwatersand, Johannesburg, South Africa, October 1984.

4. D. Laguitton and E. Ter Heijden, *Computation path organization for process simulation by the sequential modular approach*, Proceedings of the 4th IFAC Symposium, Helsinki, Finland, 1983.

5. F. Flament, D. Laguitton, E. Ter Heijden and P. Chassat, SPOC manual, *Chapter 6: Plant Simulators for Mineral Dressing*, CANMET, Energy, Mines and Resources Canada, 1985.

6. *Disk Operating System*, Version 3.1, Reference, International Business Machines Corporation (IBM), P.O. BOX 1328–C, Boca Raton, FL 33432, U.S.A., 1985.

7. *Fortran Compiler*, Version 4.01, Microsoft Corporation, 16011 NE 36th WAY, BOX 9717, Redmond, WA 98073–9717, U.S.A., 1987.

8. Peter Norton, *Programmer's Guide to the IBM PC*, Microsoft Press, Bellevue, WA, U.S.A., 1985.

9. *Disk Operating System, Technical Reference*, International Business Machines Corporation (IBM), P.O. BOX 1328–C, Boca Raton, FL 33432, U.S.A., 1985.

10. M. Bilodeau, *Development of Screen Management Subroutines Compatible with Microsoft Fortran Compiler*, CANMET, Energy, Mines and Resources Canada, 1988.

11. *SideKick, The Desktop Organizer*, Borland International, INC., 4585 Scotts Valley Drive, Scotts Valley, CA 95066, U.S.A., 1985.

12. D. Cimon and M. Bilodeau, SPOC library, Version 2.0, *A Package that allows full screen editing using FORTRAN language with Personal Computer*, CANMET, Energy, Mines and Resources Canada, 1988 (in progress).